Applicant has stated in the specification that in the production of semi-conductor devices there is a continuing increase in device density and a concomitant decrease in device geometry. The present invention relates to high performance multiplayer resist structures including bilayer and top surface imaging (TSI) methods and fabrication thereof.

Vikesland, which issued in 1986, discloses a system which inherently contains the problems discussed by Applicant the description of the prior art. Both bilayer and TSI require a carefully designed underlayer which does not interact with the resist and exhibits no interfacial mixing with the resist. It is essential that products from the underlayer cannot diffuse into the resist that can contaminate the resist, and components from the resist cannot diffuse into the underlayer.

Applicant notes in the specification that the most typical underlayer used in bilayer and TSI has been cross-linked novolac/diazonapthoquinone (DNQ) systems. The novolacs as disclosed by Vikesland have many disadvantages as described. In particular, high temperature (>200C) is needed to cross-link, the system must be carefully designed and controlled to prevent resist/underlayer interaction, its optical properties are significantly dependent on baking conditions. Thus, to be able to use novolac systems in a bilayer, TSI process- the chemical composition and processing conditions must be controlled as described below, otherwise significant interfacial interaction with the resist is observed limiting the ultimate resolution attained with the resist.

The thermal decomposition of the DNQ results in the formation of a highly reactive ketene intermediate that can form crosslinking ester functionalities with the phenolic sites of the matrix novolac. The crosslinking of this resin is essential to induce insolubilization and prevent dissolution during the solvent casting of the imaging layer. However, it was shown that underlayers formed from novolac/DNQ produced an interface interaction with the imaging layer that results in gross residual material or "scumming" after development. This artifact of the underlayer prohibits its use within this system. Based upon the work done by Vinesland, these problems were inherent in his method and are the basis for the improvements developed by Applicant.

In an effort to remedy this situation, Applicant determined that in the absence of a DNQ additive, novolac can be caused to insolubilize simply by thermal curing of a solvent-removed, spin cast film. Prolonged curing (2-5 min.) at elevated temperature (225-275 °C) is preferred. Films prepared in this manner were insoluble in common casting solvent and allowed for casting of the top imaging layer without severe mixing. The severity of the residue after development was greatly diminished as compared to the DNQ/novolac underlayer; however, some residue was persistent. Although the mechanism of this insolubilization has not been determined, it is proposed by Applicantto occur due to densification of the glassy film after prolonged heating above its glass transition temperature (Tg) coupled with a complex combination of thermally induced oxidation and/or electrophilic aromatic substitution, resulting in a crosslinked network. Evidence for these proposals lie in the dependence of the molecular weight (Mw) and polydispersity index (PDI) of the novolac polymers and the dependence of the optical properties (n & k) on the curing conditions as shown in Example 5 in the specification.

It was found that those polymers with higher Mw values resulted in underlayers that produced . . less scumming. This was also the case with materials of higher POI. It is proposed that residue is largely caused by an interaction of the imaging layer with the underlayer. It is evident that the-degree and/or efficiency of crosslinking of the underlayer greatly contribute to this deleterious phenomenon. The amount of residue clearly correlates inversely with both the Mw and the PDI of the novolac used in the formulation. Therefore, it is desirable to have a novolac of high MW and a broad PDI for minimization of residue.

The degree of crosslinking is directly dependent on 1 presence of polymeric chains of greater length, i.e. higher Mw. It also appears that the presence of lower molecular weight species is important to the degree of cross linking as the increased ratio of functionalized hydroxymethyl "end-groups to repeat groups in these oligomers is high and leads to more crosslink sites per chain. The Mw of novolac, as noted in the specification, is in the range of 2K-50K, more preferably from 2k-25K and most pre from 2k-15K.

Another problem with the novolac is that oxidation clearly occurs in these films which is apparent by the observed change in the optical density in the near UV and visual spectrum. The optical absorption dramatically increases with increased curing temperature and time, consistent with the *formation* of highly absorbing quinoidal-type species. However, since the optical properties change with a minor change in processing conditions as shown in Example 4, it is very important to tightly control the processing conditions to prevent significant variations in optical properties.

The best cross-link temperatures, as noted in the specification is between 200 and 300C, more preferably from 225-275C, and most preferably. 225-260C.

A fundamental disadvantage of the described underlayer system is in the mechanism of insolubilization, i.e., crosslinking, is not well understood. An optimum underlayer has been designed by Applicant by including specific functional groups in combination with the polymer and formulation that can contribute a particular attribute. The formulation consists of a polymer matrix system, a thermal acid generator,and a polyfunctionalized crosslinking agent.

Each component serves its particular purpose (optical properties, insolubilization and etch properties)-on the basis of the chemical composition. In concert these materials provide all the desired characteristics not possessed by Vinesland.

The Examiner states in the rejection "Clearly coating and heating the novolac resin in the presence of a diisocyanate compound a crosslinking reaction occurs between the novolac resin (having phenolic groups and the diisocyanate compound in the first layer...This disclosure is asserted by inherency to meet the claimed 'layer of material' coated on the 'surface' of claim 1." There is no positive recitation in Vikesland that the crosslinking reaction would occur as the Examiner asserts above. Further the constituents that make up the layers on the instant invention and Vikesland are different. Because there are different components in each composition, one cannot state with certainty that a given phenomenon, such as a reaction, will occur. The thermodynamics of the reactions control what will occur.

As for the second layer, the Examiner again cites an inherent anticipation. Because Vikesland discloses a naphthoquinone diazide photosensitizer, he contends that this compound would meet the recited material index of refraction. There is no basis to assert that the energy beams of claims 5 and 7 are met by the disclosure of Example 1 of Vikesland. The term "met" connotates that the rejection is one of anticipation. The standard for anticipation is that the disclosure must include each and every element found in the claim under examination. Each and every element is not positively recited in the reference. Based upon the limited disclosure in Vikesland there are a number of unwarranted assumptions that must be made in order to arrive at an anticipation of claims 1-4, 5, 7 and 18.

Applicants have discussed in detail in the specification and in this amendment that there are critical features that must be present in the two layers so that they will not intermix. Vikesland makes no reference to this feature in his disclosure.

In the last paragraph on page 3 of the Official Action, the Examiner is contending that the present invention is obvious based upon inherency, as opposed to anticipation. The "same type of ingredients" is not the standard for 35 U.S.C. 102(b). There also is no basis for the statement that the dry film resist has no intermixing.

Further, the reference must describe the applicant's claimed invention sufficiently to have placed a person of ordinary skill in the field of the invention in possession of it. (Citations omitted) In re Lonnie T. Spada et al., 911 F.2d 705, 708 (Fed. Cir. 1990).

The Vikesland reference does not place the skilled artisan in possession of the instant invention. Applicant has pointed out the problems with novolac and has developed a system which is different in kind from that disclose.

The Examiner's obviousness rejection of the claims is incomplete as he has not provided the proper foundation for the rejection relating to his assertions as to the first and second layers, etc. This portion of the rejection of claim 1 et seq., is based upon assertions by the Examiner as to the purported content of the prior art. 37 C.F.R. 1.104(d)(2) states "...When a rejection in an application is based on facts within the personal knowledge of an employee of the Office, the

data shall be as specific as possible, and the reference must be supported, when called for by the Applicant, by the affidavit of such employee, and such affidavit shall be subject to contradiction or explanation by the affidavits of the applicant and other persons..." Applicants submit that the Examiner should comply with the excerpt of 37 CFR 104 cited above and provide the required information relating to the inherency to Applicant.

The compound named "Resinox" is defined in the *Concise Chemical and Technical Dictionary* (1986) page 983 as a number of compounds which are melamine molding compounds. Melamine is (2,4,6-triamino 5-triazine cyanuro triamide [$N:C(NH_2)N:C(NH_2)N:C(NH_2)$] *Id.* Page 741. This disclosure is at odds with the disclosure of Vikesland.

The Examiner is requested to reconsider the rejection under 35 U.S.C. §102(b) of Claims 1 – 5, 7, 8 and 18 as being clearly anticipated under 35 U.S.C. §102(e) by Pavelcheck et al. (5,939,236).

Pavelcheck et al. provide new light absorbing compositions suitable for use as antireflective coating compositions made up of a resin binder and a photoacid generator that reduce footing and notching. Pavelcheck et al. do contemplate that the layers will intermix where they state in the specification: "In other words acid diffusion or neutralization from a resist layer can be compensated for by the presence of photogenerated acid in the antireflective composition..." All of the elements of Claim 1 as presently amended are not found in the Pavelcheck, et al. disclosure.

The Examiner is requested to reconsider the rejection of Claims 1 – 8, 18 and 20 under 35 U.S.C. §103(a) as unpatentable Pavelcheck et al. (5,939,236).

The Examiner has cited Claim 18 as a basis for the obviousness rejection. Claim 18 of Pavelcheck et al. claims a coating layer of an antireflective composition comprising a resin binder, a photoacid generator with the antireflective composition being free of a crosslinker component. Applicant's base possesses a polyfunctionalized crosslinking agent. Applicant's teaching is diametrically opposite to that of Pavelcheck, et al.

The Examiner has selected certain elements from the cited reference for the sake of showing the individual elements claimed without regard to the total teaching of the reference.

The Examiner in his application of the cited references is improperly picking and choosing. The rejection is a piecemeal construction of the invention. Such piecemeal reconstruction of the prior art patents in light of the instant disclosure is contrary to the requirements of 35 U.S.C. § 103.

> The ever present question in cases within the ambit of 35 U.S.C. § 103 is whether the subject matter as a whole would have been obvious to one of ordinary skill in the art following the teachings of the prior art at the time the invention was made. It is impermissible within the framework of Section 103 to pick and choose from any one reference only so much of it as will support a given position, to the exclusion of other parts necessary to the full appreciation of what such reference fairly suggests to one of ordinary skill in the art. (Emphasis in original) In re Wesslau 147 U.S.P.Q. 391, 393 (CCPA 1965).

This holding succinctly summarizes the Examiner's application of references in this case, because the Examiner did in fact pick and choose so much of the Pavelcheck, et al. reference to support the rejections and did not cover completely in the Office Action the full scope of what the references fairly suggests to one skilled in the art.

Applicants have attempted in this response to revise the language of Claim 1 in this case to specifically define the invention to clear up any ambiguities that may have existed in the wording heretofore. Applicant believes that the amended claims are in a form which should result in their allowability. If the Examiner wishes to discuss via telephone, the substance of any of the proposed claims contained herein with the intent of putting them into an allowable form, Applicants' attorney will be glad to speak with him at a mutually agreeable time and will cooperate in any way possible.

The Commissioner is respectfully requested to extend for one month, the period of time within which to respond to the May 3, 2005 Official Action. A check in the amount of $110.00 is enclosed to cover the required one month extension fee.

Respectfully Submitted,

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I certify that this amendment is being deposited with the United States Postal Service, sufficient postage prepaid on the date shown below addressed to: *Assistant Commissioner of Patents, P.O. Box 1450. Alexandria, VA 22313-1450*

Signature _____ Date: August 29, 2005
Name: Thomas A. Beck